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Ecological studies on zooplankton species important for fish farms. II. Interspecific relations between zooplankton species

By

I. KISS

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ABSTRACT. Some cases of competition and predation were examined in Rotatoria and Cladocera species providing the fish progeny with a basic natural food. In the Rotatoria breeds, Brachionus calyciflorus, which multiplies rapidly, appeared in the beginning, then reproduction of the consuming predator Asplanchna species commenced. It has been established that the Cladocera species are able to crowd out the Rotatoria species from the biocenosis of the progeny breeding ponds. There exists a competition for food between the two Cladocera species too, as a result of the more intensive filtering activity. In the case of Brachionus calyciflorus, in the presence of the predator Asplanchna species spine length increases, which means unambiguous protection for the adult animals, and also for most of the young ones.

KEY WORDS: zooplankton breeds, population dynamics, competition, predation, cyclomorphosis

INTRODUCTION

The biological relations in zooplankton communities can generally be observed in connection with the phenomena of nutrition, respiration, reproduction, defense, vertical and horizontal distribution (SEBESTYÉN, 1959). Since the environmental active components function in a complex way, the communal relations of different characters correlate with one another concurrently.

Amongy the biotic relations, food relations can be considered as most important. In the characterization of the feeding of planktonic animals, the size of the food, the relation of the consuming animal and the nourishment in terms of order of magnitude, and research on the ways of ingesting the food particles are significant besides the description of the formal and functional features of the nutritive organs (SEBESTYÉN, 1959).

The character of the relations among the species was revealed by research on population dynamics. From the changes in the population dynamics of co-existing species (in presence of certain species the low number of individuals of other species, the sudden disappearance of some species from the water habitat) a conclusion could be drawn as to the existent phenomena of competition and predation. Several experiments prove that zooplankton species requiring similar environmental conditions and food partition the regions of the water habitat among themselves, thus showing definite vertical and horizontal distribution (MAKAREWICZ and LIKENS, 1975; LANE, 1978, HALBACH, 1979). Certain planktonic organisms form communities of seasonally varying composition of species as a result of the difference of their ecological requirements. Thus, e.g. in the case of most Cladocera spp., it can be proved that they are not concurrently present in a water habitat (LYNCH, 1978). Besides predation, the decrease in the number of individuals of certain populations can also be caused by competition. The clarification of the causal relations is rendered more difficult by the fact that a species normally practising filtering activity can appear as a facultative predator species. This is true for most Copepoda spp. (PUJIN, 1971).

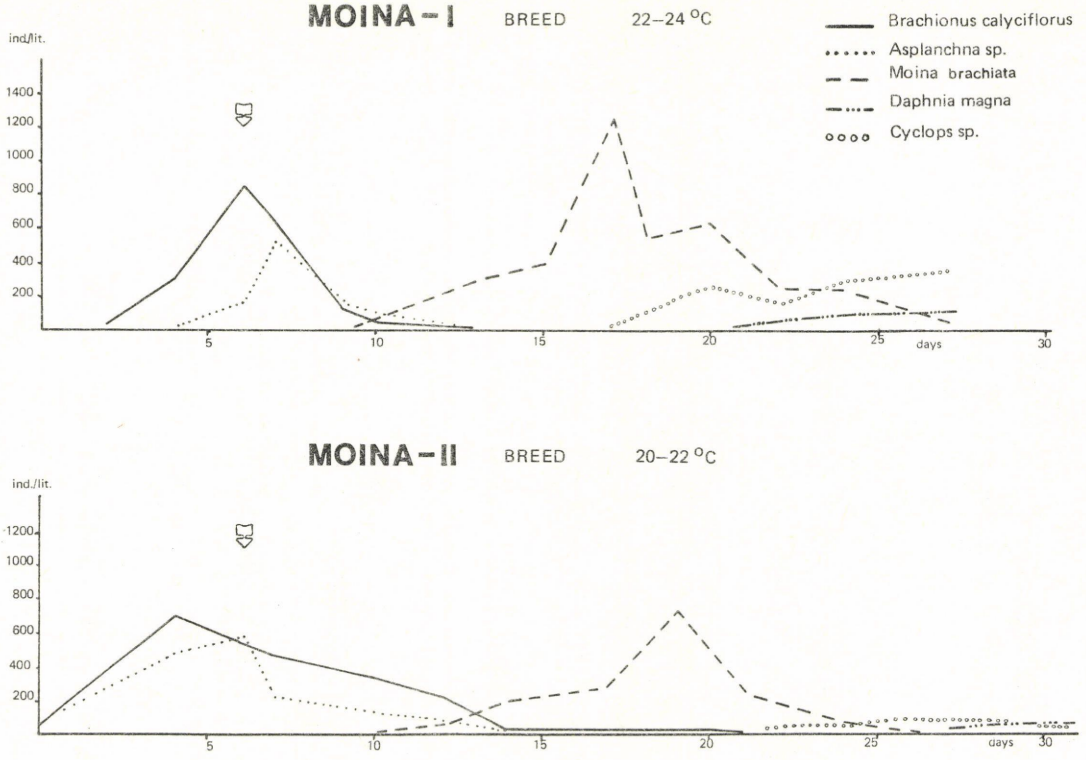

Fig. 1 Change in density of the various species in the Moina brachiata breed. Guide to symbols:
= The introduction of the basic Moina population

The Cladocera spp. react to the attack by the predators (planktonic species or fish) by changing the proportion of their bodily parts in size (LYNCH, 1977; DODSON, 1974). Cyclomorphosis serves as a means of defense against being taken as a prey by fishes. The selective consumption of fishes results in the evolutionary change of the cyclomorphosis of the plankton members (JACOBS, 1977).

In fresh-water lakes the interactions between the Copepoda and Cladocera spp. appear in an extremely complex form both morphologically and ethologically. For instance in the case of Bosmina the lengthening of the antennae and spines is accompanied by the thickening of the endoskeleton, which ensures protection against the copepods. There is protection in the sphere of multiplication too, as the larger eggs with more yolk lead to a shorter period of embryonic development (KERFOOT and PETERSON, 1979).

It is has been long known that in the case of Brachionus calyciflorus, a modification of spine-length can be observed. It has been proved by experiments that the increase in spine is induced by external factors, the most influential of which is the presence of the predator Asplanchna spp. in the given water habitat. The peptide derivative discharged by the Asplanchna into the medium enters the body of Brachionus calyciflorus, and induces the encrease of the spine-length of the off-springs by influencing the ova in the female's ovary. The increase of the spine-length of the new-born animals reflects the last day's population density of Asplanchna (HALBACH, 1970). This correlation is true only for the new-born, since the older animals are not influenced by the induction of the Asplanchna.

This compound is permanently produced and discharged into the medium by the Asplanchna. However, if they die out in a water habitat, this compound disappears very quickly (in one or two days), so it has no effect on the new-born Brachionus (HALBACH, 1971).

The lengthened spine, which can be stiffened, provide the Brachionus calyciflorus with an effective device for protection against being swallowed by the predator Asplanchna. The larger the spines are the safer the protection against the predators. Even in the case of very young and small individuals of Brachionus calyciflorus, the advantage of the spined animals can be proved (HALBACH, 1979).

MATERIALS AND METHODS

We made our investigations in the 100 m^2 fish-progeny breeding ponds on the Tempered Watered Fish-breeding Farm of Százhalombatta. Using the selective plankton preparation method (TAMÁS and HORVÁTH, 1975; TÖLG, 1981) we created pure Rotatoria breeds, in which the number of the Brachionus calyciflorus (Pallas), Asplanchna priodonta (Gosse), Asplanchna brightwelli (Gosse) species was overwhelming. Using the above-mentioned method we also created pure breeds in the case of two Cladocera species (Moina brachiata/Jurine/, Daphnia magna Straus).

The detailed description of the methods is given in KISS (1985).

In the present work we used the data of the underlisted experimental lakes (the starting date of the experiments means the filling up of the lakes):

Moina brachiata breed:

I. 15. July, 1975. - 11. August, 1975. (15 samples in 27 days)
II. 8. August, 1975. - 8. September, 1975. (14 samples in 31 days)

Daphnia magna breed:

I. 20. July, 1975. - 22. August, 1975. (16 samples in 32 days)
II. 8. August, 1975. - 8. September, 1975. (13 samples in 31 days)

Rotatoria breed:

I-IV. 22. September, 1976 - 25. October, 1976. (10 samples in 34 days)

The Moina-I, -II and Daphnia-I, -II breeds are identical with the ones analysed in detail in KISS (1985).

In addition to following closely the number of individuals of the Rotatoria species, it was also necessary to take the measurements of the postero-lateral spine (PL) and the lorica length (L) of the individuals of Brachionus calyciflorus. We took the measurements of 45-50

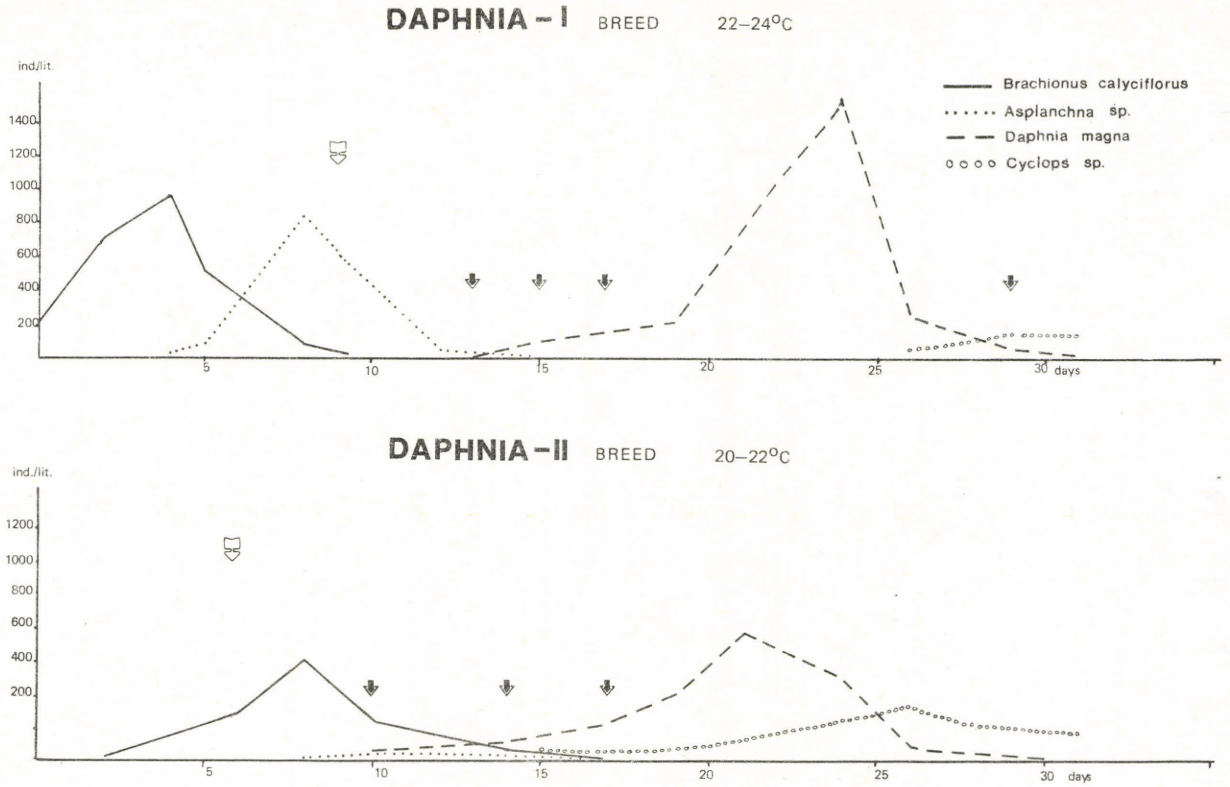

Fig. 2 Change in density of the various species in the Daphnia magna breed. Guide to symbols: = The introduction of the basic Daphnia population, = Moina presence

individuals on every sampling occasion. The index, calculated from the dimension of the two measurements I= PL/L, can be used to demonstrate the evolving cyclomorphosis, the appearance of Asplanchna (HALBACH, 1971).

RESULTS AND EVALUATION

A. Cladocera breeds

In the Cladocera breeds (Figs 1 and 2), in the starting slow period of reproduction we observed a significant Rotatoria stock, the quantity of which gradually decreased parallel with the reproduction of the Moina and Daphnia populations, respectively. Among the Rotatoria species, the reproduction of Brachionus calyciflorus started first multiplying very quickly, and it was followed by the consumer, the predator Asplanchna species.

In the Moina breeds (Fig. 1), parallel with the aging of the stock the food competing Daphnia species with better body construction and more intensive filtering activity, as well the Cyclops species increased significantly in number.

In the Daphnia breeds (Fig. 2) during the starting period, it could be observed that besides reproduction of the Rotatoria species, after the introduction of the Daphnia basic population only for five days and only with a low number of individuals (50 ind./lit.) was the Moina population present. Presumably the inoculum was accompanied by some individuals, but it is more probable that the individuals born from the ephippial eggs stuck to the plants at the edges of the pond and left from the previous fish breeding period, multiplied. They could not increase in number significantly, because the food competitor Daphnia magna, with better body construction, and quicker consumption proved to be stronger and soon multiplied in large numbers.

B. Rotatoria breeds

In every case following the flooding, the individuals of the Brachionus calyciflorus species multiplied, then between the 10th and 15th days Asplanchna spp. also appeared in the water habitat. It can be observed in Figs 3 and 4 how sensitively the young Brachionus calyciflorus individuals reacted to the very low density of Asplanchna. Very few Asplanchna individuals per litre (3-5 ind./lit.) can already induce the growth of the postero-lateral spine, thus, the value of the "I" index increased. It is worth mentioning that the change of the proportion of the body size can already be observed when Asplanchna could not yet be identified in the water-sample. Asplanchna spp. are able to co-exist for a long time in large numbers with their prey animals: this is made possible by their ability to swallow some small-spined individuals with low "I" index of the Brachionus calyciflorus species, and the spineless, common individuals of B. angularis and B. rubens. In our breeds B. rubens individuals multiplied, and provided the Asplanchna spp. with easily available food. This is why the Asplanchna spp. survived in large numbers in spite of the marked decrease in numbers of Brachionus calyciflorus in two of our breeds (Fig. 4).

If only Brachionus calyciflorus individuals can be found in the water habitat, Asplanchna spp. are able to exist only in small numbers as a consequence of the food shortage. They survive longer in comparison with the case when they co-exist with spineless prey animals (HALBACH, 1971). This is the result of the fact that there are individuals with low "I" index value in every Brachionus calyciflorus population as the consequence of genetic variability.

However, considering that the selectional pressure of the Asplanchna spp. is aimed at the increase of the "I" index, the mechanisms of this constant co-existence need further investigations.

SUMMARY

The investigated Rotatoria (Brachionus calyciflorus, Asplanchna priodonta, Asplanchna brigthwelli) and Cladocera (Moina brachiata, Daphnia magna) species are the most important members of the zooplankton stock of several natural waters and fishponds in Hungary from the point of view of fish-breeding.

The Cladocera species are able to exclude the Rotatoria species from the biocenosis

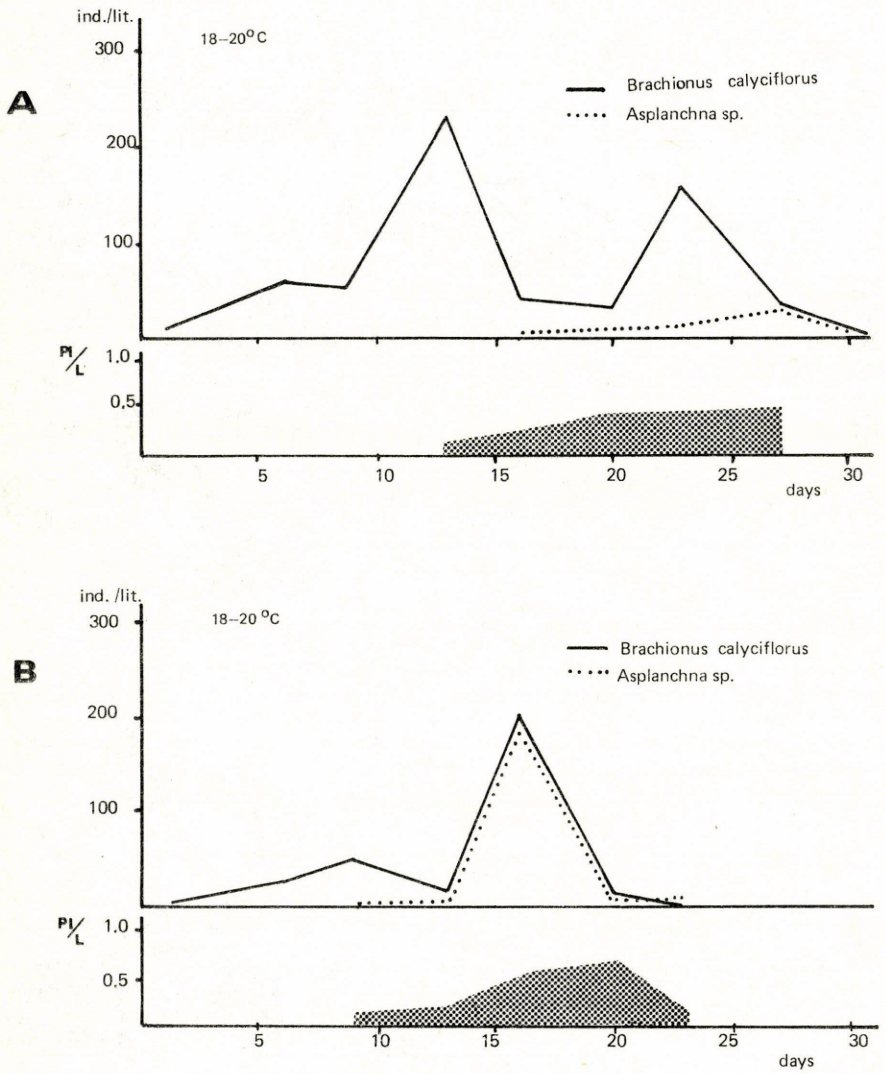

Fig. 3 Change in density of individuals of the Rotatoria spp. and the values of "I" index in the Rotatoria breeds I and II. - A= Rotatoria breed-I, B= Rotatoria breed-II

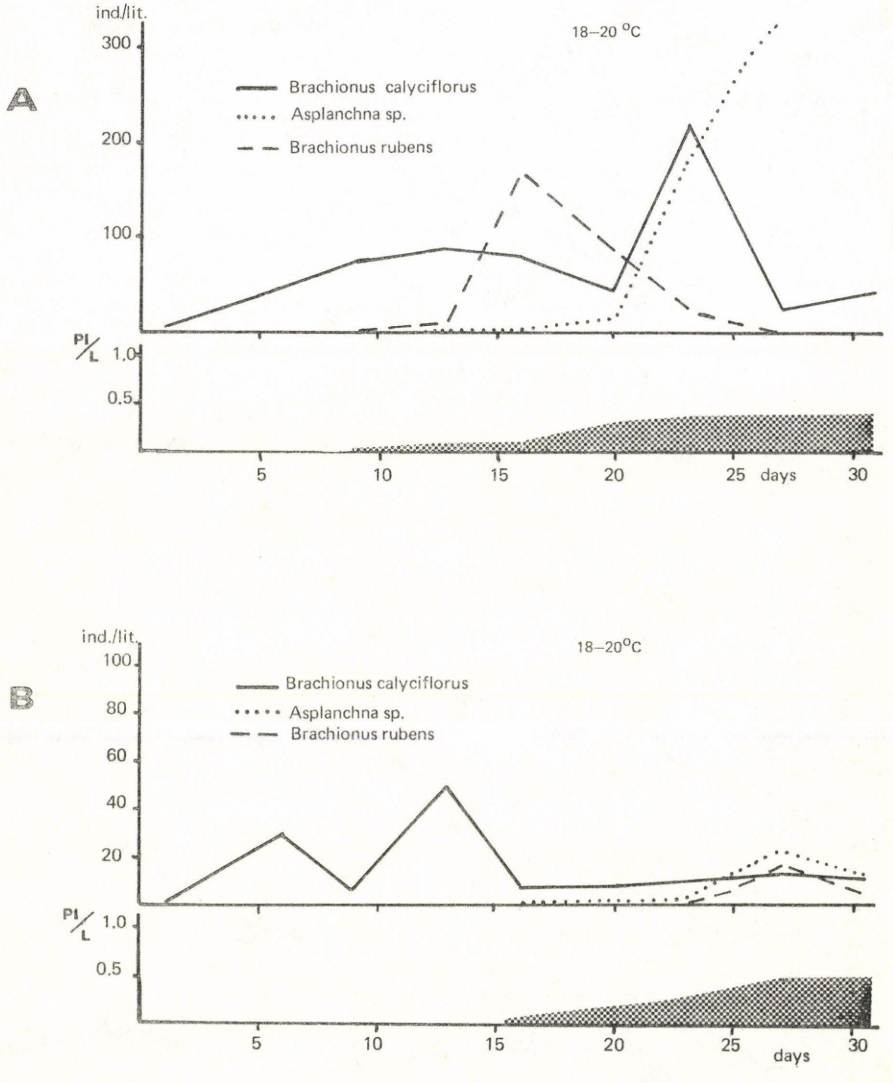

Fig. 4 Change in density of the Rotatoria spp. and the values of the "I" index in the Rotatoria breeds III and IV. - A= Rotatoria breed-III, B= Rotatoria breed-IV

of progeny breeding ponds. One of the reasons is undoubtedly the competition for food due to the more intensive filtering activity. This phenomenon exists between the two Cladocera species, too.

If, for some reason, the proliferation of the Cladocera spp. is hindered (e.g. in the case of the use of substances with trichlorfon as the agent), the stock of Rotifera, both filtering and predator species, may grow to significant size.

Thus, with the above mentioned correlations taken into consideration, it can be understood why the progeny must be introduced into the ponds on the day following the flooding in technologies using selective plankton preparation. After the flooding, the Rotatoria spp. become predominant in the zooplanktonic stock of the pond, and they serve as the first food for the progeny.

As an example for the prey-predator relationship, we showed the co-evolutionary relationship between Brachionus calyciflorus and Asplanchna spp. The Brachionus calyciflorus population is sensitive in its reaction to the presence of Asplanchna spp., namely the proportions of the body construction of the new-born change, spine length increases, which serves as an effective means of protection against predators. The grown-up individuals are practically invulnerable, whereas some of the young can be ingested by the Asplanchna spp.

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Author's address: Dr. István KISS
Department of Zoology
University of Agriculture
H-2103 Gödöllő
HUNGARY